A SUBTROPICAL MIOCENE FAUNA IN ARCTIC SIBERIA.

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(With Plate LVI.)

In the northeastern angle of the Okhotsk Sea, between the parallels of 58° and 62° north latitude and in about 158° east of Greenwich, lies a large body of water known as the Gulf of Penjinsk. It extends in a northeast and southwest direction for about 300 miles and has a greatest width of some 140 miles. At its head it is divided by a large peninsula into two narrower arms, of which the westernmost is called the Gijigá Bay and the other Penjinsk or Zhinsk Bay.* At the head of the former a small river comes in, some distance up which is the small Russian trading post of Gijígá, which, to the best of my knowledge at present, is the only permanent settlement anywhere about the gulf.

This arm of the Okhotsk Sea has not been visited, so far as recorded, by any scientific explorer, unless we except the officers of a small coast-guard steamer maintained by the Russian Government in the Okhotsk Sea, and who did some hydrography in this vicinity. No collections from this region are mentioned in any work on the natural history of this region which is accessible to me.

From Russian travelers and the explorers of the Telegraph expedition of 1865–'67, as well as the whaling captains of the North Pacific fleet, something is known of the characteristics of the gulf. It is ice-bound for more than half the year. Late in May simultaneously with the freshets in the rivers falling into the gulf, the ice near its head and along its shores becomes loosened and a certain amount of open water will be formed between the main floes of the Okhotsk Sea and the land about the gulf. A large number of whales, supposed to be a variety of the true Arctic Bowhead or *Balæna mysticetus*, were formerly in the habit of resorting to these sheltered bits of open water where they brought forth their young. This came to the knowledge of the whalers, and about 1849 the whale fishery was established in the Okhotsk Sea and maintained there until the whales became too scarce to warrant their pursuit. Since the ice prevented the access of the whale ships, they were accustomed to send boat parties through the

* The nomenclature in these parts is somewhat unsettled and charts differ, but the names here used are derived from the Russian Hydrographic Office chart.

narrow strip of open water along the shores until the open water at the head of the bays was reached, according to Scammon, usually about the 20th of June. With the boats whaling was carried on from camps on shore until, in July or later, the main floes had so broken up as to allow the ships to penetrate the bays.

The shores around the gulf are, in many places, cliffy or precipitous and the beaches stony, though the depth of water is moderate, nowhere exceeding 100 fathoms, as far as known. While the latitude of Penjinsk Gulf is that of Shetland or the South Cape of Greenland, and it is not within the Arctic Circle, yet its climate and conditions are essentially arctic, and it is the only region where the true arctic whale has ever been known to breed except in the Polar Sea. The marine fauna probably resembles that of other parts of the Okhotsk Sea where it is known to be extremely scanty along the shores, profuse in individuals in water deep enough to be free from grounding ice, and strictly arctic everywhere. Further south, off the west shore of the peninsula of Kamchatka, is a noted codfishing ground, but no record of any attempt to fish in the gulf has been brought to my notice. In the summer a fairly large run of salmon of several species occurs in most of the rivers falling into the gulf and wild fowl are abundant spring and fall as they come and go from their breeding grounds at the mouths of the rivers farther north.

On the shore of one of the small bays which put out from the gulf coal has long been known to exist, though the exact locality is not indicated on any of the charts I have been able to examine. The place was known to the whalers as Coalmine or Coal Bay. In 1866 the Russian transport *Sakhalin*, which had brought supplies for the telegraph explorers, being short of coal, obtained a quantity from this place, which enabled her to reach the Amoor River, though the quality of the fuel was poor. It seems to resemble the Eocene lignites of Alaska rather than the coals of greater age and density.

From this locality in 1855, when a member of the Ringgold and Rodgers exploring expedition in the North Pacific, the late Dr. William Stimpson obtained a small collection of fossils, comprising six species of mollusks, which were deposited by him on his return to America in the Museum of the Smithsonian Institution, where they have since remained.*

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*Although no extended data accompany the specimens, I learn through the courtesy of Lieut. Commander Richardson Clover, U. S. Navy, hydrographer of the Navy Department, that the U. S. S. *Hancock*, Lieut. H. K. Stevens, U. S. Navy, commanding, visited Coal Bay early in August, 1855, and it was doubtless by some one on board that the species were collected. The position assigned to Coal Bay on the map of the expedition is in latitude 60° 17 north and longitude 161° 55 east of Greenwich. It is noted that coal was found abundantly, but of inferior quality for generating steam. Some account of the *Hancock's* visit to Coal Bay is given by A. W. Habersham in his volume entitled "My Last Cruise" (etc.). Philadelphia, Lippincott, 1857, pp. 329–371.

The aspect of these shells indicates for them a Miocene age, to which they were assigned by the late paleontologist F. B. Meek. The matrix is a light-brown or grayish, fine grained, rather hard sandstone, exactly like many of the Miocene sandstones of the adjacent Alaskan coast. Taking the occurrence of the beds of lignite into consideration we may suppose that they are, like the Alaskan lignites of the opposite shore of Bering Sea, immediately succeeded by a bed of marine Miocene, from which these fossils may have been derived. In cleaning off some adherent matter it was found that a few small particles of a stony alga still adhered to the fossils and retained some of its original green color. This shows that the alga is not a fossil, and indicates that the specimens were obtained upon the beach, where they may have remained some time after being weathered out of the original matrix. One specimen, a large oyster, is somewhat worn, as if by the waves, and still retains in its shell substance something of the purple color which characterized the shell while living.

DESCRIPTION OF THE SPECIES.

Ostrea gigas Thunberg.

Ostrea gigas Thunberg, Kong. Vet. Ak. Handl. t. XIV, for 1793, p. 140, pl. 6, figs. 1–3; Lischke, Jap. Meeresconch, I, p. 174, 1869; II, p. 160, pl. 14, figs. 1, 2, 1871; III, p. 114, 1874; Dunker, Ind. Moll. Jap. p. 249, 1882.

Ostrea Laperousii Schrenck, Bull. Imp. Acad. Sci. St. Peterb, IV, p. 411, 1861; Reisen in Amurl., Moll., p. 475, pl. 19, figs. 1–6, 1867.

Ostrea talienwhanensis Crosse, Journ. de Conchyl., X, p. 149, pl. 6, fig. 6, 1862.

Ostrea talienwahuensis Sby., Conch. Icon. Ostrea, pl. 10, fig. 21, 1871.

? *Ostrea borealis* Jay, Perry's Japan Exp. p. 296.

Coalmine Bay, Gulf of Penjinsk, Okhotsk Sea, W. Stimpson, Mus. Reg. No. 4787.

The fossil comprises the whole of the upper and most of the lower valve, held together by the indurated matrix and measuring about 103 millimetres long by 90 millimetres in greatest width. The specimen is somewhat waterworn, evidently after weathering out of the matrix, but retains partly the purplish color common to this species. It appears to agree in all essentials with the recent shell.

This oyster has, like the *O. virginica* of America (which it much resembles), a very wide range in latitude, extending from the China seas to the west coast of the island of Sakhalin and in Japan to Nagasaki. But the fossil, so far as its condition permits us to judge, represents the southern form of the species rather than that which it assumes near the northern extreme of its present range.

Semele Stimpsoni n. s.

Pl. LVI, fig. 5.

Shell sub-orbicular, moderately compressed, sculptured with numerous wide, low, rather irregular concentric ridges which are angulated

at the summit and sometimes broken up or confluent on the posterior part of the shell; also by fine radiating striæ, strongest near the beaks, crossed by obvious incremental lines and nearly or quite obsolete toward the base, in the adult; the posterior fourth of the shell is marked off from the rest by an obscure radial depression which gives the hinder end the appearance of being slightly compressed and twisted to the left; cardinal region behind the beaks marked by an obscure narrow lanceolate impressed area or escutcheon; hinge with (in the left valve) a large cartilage pit, in front of which is a narrow, thin cardinal tooth with an anterior lateral very short and closely adjacent, the posterior lateral also extending but little behind the end of the cartilage pit; interior surface smooth, the pallial line distinct, the sinus broad, bluntly rounded in front and extending to a vertical line dropped from the beak. Lon. of left valve, 33; alt., 30; semidiameter of shell, 7 millimetres.

Two left valves (Mus. Reg. No. 4788) were obtained from the bed at Penjinsk Gulf by Dr. Stimpson, in whose honor the species is named.

This species most closely resembles *S. modesta* A. Adams* from West Africa and St. Helena, a species which is somewhat higher, more inflated, with longer lateral teeth, a smaller cartilage pit, and more rounded concentric sculpture. In both the sculpture near the beak tends to be more nearly lamellar and the radiating grooving more prominent.

The nearest relative geographically which *S. Stimpsoni* possesses is the similarly sculptured form, referred to by Schrenk under the name of *S. californica*, which is found in the Japan Sea and the Strait of Tartary. While many Japanese shells are common to Northwest America, it can hardly be said that the identity of this species, which I know only by Schrenk's figure, with the Gulf of California shell is fully established. It is possible that our fossil may prove identical with the living form recorded by Schrenk, but this can only be determined by a comparison of specimens.

* This was referred by Mr. E. A. Smith, of the British Museum, to *S. cordiformis* "Chemnitz," which is the West Indian and East American species variously known as *S. reticulata* (Gmel.) Wood, *orbiculata* and *radiata* Say, *subtruncata* Sby., *Jayanum* C. B. Adams, and *pulchella* A. Adams. From these, however, the St. Helena shell is quite distinct, as shown by a series kindly presented to the National Museum by Capt. Turton. Its sculpture is never sharp and rasping to the touch as in the West Indian shell, and all the specimens (five) show a minute lunule, under which the shell substance is of a deep claret-brown color, forming a very conspicuous spot of color and not occurring in any of the American shells from over fifty different localities. The concentric ridges are broad and blunt in the *S. modesta*, while they are represented in the American species only by thin sharp lamellæ. As Chemnitz was a binomial writer only accidentally, and did not adopt the Linnean system of nomenclature, his name can not be accepted even for the American shell, which will best be known by the name of Gmelin, adopted and illustrated by Wood, in the belief that the shell is the *Tellina reticulata* of Linné, a conclusion to which the researches of Hanley on the Linnean types lend a reasonable probability.

Siphonaria penjinæ n. s.

Pl. LVI, fig. 2.

Shell irregularly ovate, depressed, alternately radiately sculptured with riblets and threads; apex eroded in the specimens, but situated at about the posterior third; lines of growth obvious; margin entire or slightly crenulated by the sculpture; interior smooth, muscular impressions strong, interrupted at the right as usual in the genus; the shells showing evident color markings consisting of alternate light and dark radiating lines much as in *S. lineolata* Orbigny. Lon. of shell, 20; max. lat., 15; alt. (somewhat eroded), 4 millimeters.

Two specimens (Mus. Reg. No. 4791) received from Dr. Stimpson.

This species recalls *S. lecanium* Cpr., of the northwest coast of America, but is very closely related to the *S. radiata* Ad. & Rve. figured from the China seas in the "Voyage of the *Samarang*." Two species of *Siphonaria*, *S. fuliginata* Rve. and *S. atra* Quoy & Gaim., are known from the present seas of Japan and Korea, but neither so closely resembles our fossil as the more tropical species above mentioned, which indeed is hardly distinguishable from the form we have described.

Conus okhotensis n. s.

Pl. LVI, fig. 4.

Shell short, stout, solid, of about eight whorls; spire low and rounded, suture appressed, with a few obscure spiral striæ in front of it; shoulder of the shell rounded; sides smooth, hardly striated even over the canal, aperture rather wide, outer lip straight, sutural sinus shallow; pillar simple, slightly twisted at the end; lon. of shell, 50; lat., 35 millimeters.

A young and an adult specimen (Mus. Reg. No. 4789) were presented by Dr. Stimpson.

This species is not unlike *Conus californicus* on a larger scale, and belongs, as well as can be judged in the absence of color markings, to a group (*Chelyconus*) which is most abundantly represented in the Moluccas and on the shores of Africa. There does not appear to be at present any closely related species on the Japanese coasts, but *C. fulmen* and *C. pauperculus* are found in that region and would in a general way be associated with it. Among the recent species in the National Museum, *C. glaucus* from the Moluccas presents the closest parallel in form and conchological characters.

In the larger of the two fossil specimens a faint indication of what might be taken as traces of spirally disposed color marks is perceptible, but these are not sufficiently distinct to permit of a dogmatic assertion that they are traces of color and not an incident of mineralization.

Cerithium cymatophorum n. s.

Pl. LVI, fig. 1.

Shell stout, solid, short, of seven or more whorls; nucleus lost; aperture defective; sculpture characterized by a constriction about the

middle of the whorl, above which there is only spiral sculpture; in front of it the whorl is marked with about eight prominent rounded waves or obscure ribs, with wider interspaces, which become obsolete on the last half of the last whorl; spiral sculpture of fine, sharp, minutely channelled incised lines with much wider, smooth, flat-topped interspaces; suture appressed; base constricted about the middle, sculptured with more crowded incised lines; pillar with a moderate callus; lon. of shell, 35; max. diam., 17 millimeters.

One specimen (Mus. Reg. 4790) presented by Dr. Stimpson.

This species is related to the group represented by *C. vulgatum* Brug., *C. guinaicum* Phil., and *C. amulum* Phil., the second of which extends its range from the Gaboon, West Africa, to the Philippines, Lord Hood's Island, and Japan, if authorities may be trusted. The fossil is, however, sufficiently distinguished from any of them by its form and sculpture. The group at present is only represented in warm-temperate, or subtropical waters. The specimen described had been attacked by *Clione* before fossilization and more or less perforated, beside sustaining the loss of its outer lip. A much smaller, but in many respects similar, species is found in the Older Miocene of Florida.

Diloma (Chlorodiloma) ruderata n. s

Plate LVI, fig. 3.

Shell small, turbiniform, rude, with little nacre, of about four whorls; whorls rounded, suture appressed and slightly constricted, sculpture only of rather rude lines of growth; surface composed of a dark shell layer, with obscure indications of spiral lines of lighter color; base full, slightly flattened, a narrow impressed area around the umbilicus, which is barely perforate and nearly covered by a small callus; aperture rounded; pillar short, concave, ending in a small, low, narrow, tooth-like prominence; throat smooth. Alt. of shell 15; max. diam. of base, 13; min. diam., 11.50 millimeters.

Two specimens (Mus. Reg. No. 4797) were received. No species very closely related to this shell is at present known from the Japanese fauna, but there are a number of them in the Australasian seas. The genus is perhaps represented by *D. perplexa* Pilsbry, of Japan. I have referred the fossil to *Diloma* rather than *Gibbula*, chiefly on account of the sculpture and scant pearly layer, but on such occasions it is impracticable to determine positively the precise relations.

GENERAL CONCLUSIONS.

The evidence afforded by these fossils indicates unmistakably that the fauna including them must have flourished in waters at least as warm as those which at present occupy the Japan Sea, at a distance of more than a thousand miles to the southward. The oyster and *Siphonaria* show that the fauna was litoral and not an offshore or deep-

water assembly. Faunally the species point to a distinct analogy with those of the China and South Japan seas, and, like the existing fauna of those seas, they indicate bonds of relationship with the west coast of Africa and the coast of Australia rather than with the Indo-Pacific fauna of northeast Africa and the Malay Archipelago. These curious analogies have been noted by all those who have studied the mollusk fauna of Japan, and their explanation is one of the trophies for which future students, with fuller geological knowledge of oriental countries, may compete. At present hypothesis could rest only on speculation.

It is not often that so small a number of specimens as those we have described would contain the elements necessary for deciding on so many points of interest, but the present case is a fortunate exception.

We may now consider the climatic relations indicated by this little collection. There are no observations on record from the Gulf of Penjinsk, but the climate can differ but little from that of Okhotsk, which is situated in the same latitude as that of the mouth of the Gulf of Penjina and some 350 miles to the westward. If there is any difference it is that the gulf is colder than Okhotsk, since Scammon indicates that open water occurs about June 20 in the gulf, while the average at Okhotsk is about two weeks earlier.

We find Okhotsk has a mean annual temperature of the air of 23.1°, spring having a mean of 23.9°, summer of 52.1°, autumn of 24.6°, and winter of minus 8.2°. The temperature of the sea water does not rise above 40° F. (except in the harbor) during the warmest part of the summer, and for two-thirds of the year it is at or below the freezing point. It may therefore be assumed that the water climate of Penjinsk Gulf does not essentially differ from that which is offered by those parts of the Polar Sea which are free from ice during the summer months. The climate of the region indicated as a natural climatic home by such an assemblage of fossils as those we have been discussing, should have a summer sea-water average temperature of 70°, and a winter average of 60° F. at least, with a minimum temperature never approaching the freezing point. As the difference between the temperature of the air and that of the water can not permanently remain much greater than 5° or 6°, it follows that the annual mean temperature of the Gulf of Penjinsk in Miocene time (or the era indicated by our fossils) can not have been much less than 60° F., and was probably higher. That is to say, since this fossil fauna flourished in these waters the annual mean temperature has diminished by 30° to 40° F., at the most moderate calculation.

It is perhaps very late in the day to refer to the hypothesis which explained the warm water Old Miocene of the north Atlantic shores by assuming a shifting of the polar axis so that the pole at that time would have been situated somewhere in central Siberia. That hypothesis has few if any friends at the present time. But it may not be amiss to point out that, if it were necessary to put a quietus on that moribund specu-

lation, the presence of a warm water Old Miocene in eastern Siberia, such as our present fossils indicate, would be quite sufficient to prove that no polar conditions in the modern sense could have existed there during that epoch of geological time.

PLATE LVI.

Fig. 1. *Cerithium cymatophorum* Dall, lon. of original 35 millimeters. Page 475.
2. *Siphonaria penjinæ* Dall, lon. of shell 20 millimeters. Page 475.
3. *Diloma* (*Chlorodiloma*) *ruderata* Dall, alt. of shell 15 millimeters. Page 476.
4. *Conus okhotensis* Dall, alt. of shell 50 millimeters. Page 475.
5. *Semele Stimpsoni* Dall, left valve, lon. of original 33 millimeters. Page 473.